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ABSTRACT

The Southwest Regional Laboratory for Educational Research and Development (SWRL) is dedicated to the belief that individual differences among students do not stand in the way of universal quality instructional achievement in the nation's schools. Important steps towards the condition of universal instructionalized achievement are: (1) the explication of instructional proficiencies; (2) the frequent assessment of instructional proficiencies; and (3) the widespread sharing of the findings of proficiency assessment. SWRL believes that the development of the means to provide the availability of proficency assessment information is currently possible although as of yet a base of such information does not exist. Through research and development, formulated here as Achievement Monitoring in Schools (AIMS), SWRL has designed a program of instructionalized achievement monitoring that is cost-beneficial and time-and-resource feasible. AIMS can be justified through study of the following issues: (1) the issue of educational equity and the bases for insuring equitable education; (2) the issue concerning conservation of a teacher's instructional resources when sufficiently frequent proficiency occurs in a classroom equipped to accommodate AIMS; and (3) the issue of cost-attractive hardware and hardware-referenced inputs and outputs that are consonant with the objectives of achievement monitoring. The greatest obstacle to effective and equitable education are the absence of a comprehensive proficiency framework against which instructional status and progress can be assessed, and the absence of a system insuring that pertinent data be collected, retained, and shared. The AIMS program was conceived to provide this framework and data bank. (MM)

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Achievement Information Monitoring in Schools (AIMS): Larger Straws in the Winds of Change

1 May 1976 Professional Paper 36

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SWRL EDUCATIONAL RESEARCH AND DEVELOPMENT

Professional Paper 36

1 May 1976

ACHIEVEMENT INFORMATION MONITORING IN SCHOOLS (AIMS): LARGER STRAWS IN THE WINDS OF CHANGE

Joseph F. Follettie

ABSTRACT

Equitable and effective education entails widespread sharing of information concerning scholastic proficiencies. This paper motivates and sketches major components of an operational capability to perform the necessary functions.

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ACHIEVEMENT INFORMATION MONITORING IN SCHOOLS (AIMS): LARGER STRAWS IN THE WINDS OF CHANGE

Joseph F. Follettie

One of W. S. Gilbert's patter songs goes:

> Now take, for example, my case.
>
> I've a bright intellectual face.
>
> . . . But whatever I try, Sir,
>
> I fail in. And why, Sir?
>
> I'm modesty personified.

The earlier and omitted lines paint the pompous ass Gilbert had in mind. American education is like that--either insufferably pompous or timidly diffident, depending on which lines one reads. Educators' pronouncements tend to vary from the self-satisfaction and rosy optimism of a Rousseau to the deep pessimism and fatalism of a Hobbes--and even to spew alternatively from the same mouth on odd and even days of the month. Moreover, the pendulum of the educator psyche typically swings from one extreme to the other without ever passing through the moderating and cautiously hopeful domain so comprehensively sketched by Voltaire.

On odd days of the month, the public is guided by straight-faced and serious accounts of accomplishment akin to those that Moliere parodied three centuries ago using a phonetics professor unlocking the secrets of the universe to an illiterate peasant and that Gilbert sculpted two centuries later in the guise of a self-analysis effected by a "modern" major general. On even days of the month, the public is informed in equally somber pontifications by the deschooling anarchists and other inheritors of the mantle of Schiller, Nietzsche, and their kindred philosophers of doom.

We are too modest on some occasions and too pompous on others concerning accomplishments and possibilities for the educational enterprise. We are not as far along as we should be but can glimpse the distant shore better than we sometimes acknowledge.

Education is our most nearly societywide enterprise. Both its successes and its failures are due to actions or inactions of many--legislators, officials at state and local levels, teachers, the public, and all of those myriad influences that shape the home as a paraeducational setting.

Occasional short-term failures of the vast educational enterprise are bound to occur. The many groups participating in American education should be commended for pursuing such failures, but must be considered less than enlightened for means used to detect and adjudicate educational ineffectiveness and inequity. Accusatory rhetoric too often is accepted as a useful substitute for hard evidence. The resulting emotional adversary proceedings might spice up an otherwise dreary life for some but provide little insight into how failures might be apprehended and corrected early enough to forestall initiating the useless exercise of scapegoating.

We at SWRL are persuaded that the advertized individual differences among students do not stand in the way of universal quality instructional achievement in the Nation's schools--soon rather than in the indefinite future. Important means to this end are the explication of instructional proficiencies, their sufficiently-frequent assessment, and the widespread sharing of the findings of proficiency assessment. All responsible interests in education endorse the need for an evidentiary base to reduce the manic-depressive pronouncements regarding education and the practice of scapegoating in the absence of such evidence. But the operational means for satisfying this need do not now exist. The thesis of this paper is that the development of such means is currently within the state-of-the-art and that the benefits of R&D to produce such an operational capability (formulated here as AIMS) is cost-beneficial and time-and-resource feasible.

Three selections that motivate and sketch AIMS are brought together in this paper. Some readers might be interested in all of these selections. Others might be interested in only the first (Chapter 1), dealing with the issue of educational equity and the bases for insuring equitable education. Others might be interested in only the second (Chapter 2), dealing with the issue concerning conservation of a teacher's instructional resources when sufficiently-frequent proficiency assessment--a prerequisite to effectively individualized instruction--occurs in a classroom equipped to accommodate AIMS. Finally, others might be interested in only the third (Chapter 3), which sketches cost-attractive hardware and hardware-referenced inputs and outputs that are consonant with objectives of AIMS.

Chapter 1

EQUAL OPPORTUNITY IN THE CLASSROOM: MANIPULATING INPUT AND/OR MEASURING OUTPUT

Time separates the classroom from the domains of adult competition. This temporal remoteness probably accounts for a general tendency of adults to support in concept the proposition of equal educational opportunity in elementary and secondary schools. This does not argue that adults in predominantly white neighborhoods endorse judicial intervention to achieve racial-ethnic balance. Rather, it argues that even frankly racist adults almost without exception endorse the notion that all children should have a fair shot at intellectual development. Few argue that minority group children or those from lower socio-economic status (SES) families should have less educational opportun[illegible] than their majority group and higher SES counterparts. The objective of educational equity is not at issue, but rather the means.[1]

Acting under the prod of civil rights legislation, undergraduate-quality sociological findings, and court decisions, judges and other public officials have tried for a decade to render the schools nondiscriminatory. Yet many parents--with cause, as evidence presented below discloses--continue to believe the schools often discriminate against children from minority groups and lower SES families. Whether education in consequence has been rendered less discriminatory cannot yet be determined; data bearing unequivocally on the issue are not yet available. Even granting some progress, most would agree that much ground remains to cover. New increments to progress must be serendipitously based so long as the prevailing defective view of educational determinants clouds the vision of the courts and their interventionist constituency. The courts have--among other lapses in clear thinking--not yet apprehended that no amount of input manipulation unaccompanied by rather frequent assessment of achievement outputs, by demographic category, will eliminate the unintentionally biased delivery of instruction by classroom teachers. They pursue input-manipulatory strategies resting on a thin empirical base while ignoring the human biases that are on view in every drawing room and closed-door undertaking. Substantial progress toward eliminating discriminatory instructional delivery will not occur until the courts and others stop passing the closed classroom door as if it were the portal to an other-sex toilet.

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[1]Those few who believe, with Boudon (1973), that social equity requires performance identity from a social enterprise will detect unequal opportunity whenever anyone achieves more than others. Educational equity herein entails only that the schools demonstrably dispense education without bias.

GENERIC MEANS FOR EQUALIZING EDUCATIONAL OPPORTUNITY

In conformity with various federal and state legislative acts, the schools amass and make available to the public rudimentary data on income, expenditures for instruction and plant expansion, and education-experience qualifications of teachers. In recent years, many school districts have been required to categorize enrollments for certain demographic characteristics--e.g., racial-ethnic category, parental socioeconomic status. The schools also collect and disseminate information on average daily attendance (A.D.A.) and relate dollar expenditures to enrollment in such forms as instructional expenditures per unit A.D.A. for a school or district.

Legislative interest in student achievement outputs of the schools is a recent phenomenon, is nonuniform across states, and is not yet well-focused. Determining the output of the schools entails solving a few technical problems at an acceptable dollar cost; however, the greatest obstacles are political--not governmental but educational. Until student achievement outputs of the schools are forthrightly and sufficiently-frequently assessed and findings placed in the public domain, the tools required to insure equal educational opportunity will not be consonant with that objective.

Three generic classes of input into the schools are manipulable--enrollment, income, and delivered instruction. While attempting to equalize educational opportunity, the courts have pursued two of these manipulatory means--equalizing enrollments across demographic categories and equalizing district and school incomes. The first of these means has received much media coverage and often has generated more devisiveness than cohesiveness in the community. White flight to the suburbs thus far has tended to defeat it. The second means has been more successfully applied--at least, for schools within a district. Understandably, in light of the data-base architecting requirements as yet unresolved, the courts have not pursued a third obvious means--obtaining the student achievement outputs constituting the necessary-sufficient evidence for detecting discriminatory instructional delivery in the classroom. Less understandably, neither the courts nor most others concerned with eliminating discrimination in education have much asked whether, the available inputs manipulated, teacher biases might not offset any beneficial consequences of the manipulatory effort. These three means are discussed in turn below.

Demographic Equalization of Enrollments

Alternative approaches can be taken to improving the demographic balance for the different schools of a district. One can seek to manipulate public opinion--e.g., by creating higher-cost magnet schools whose offerings or instructional effectiveness more attract the parents of some students, without regard to demographic category, than do

conventional schools. An approach under this heading typically is denoted a voluntary integration plan. Or one can directly manipulate enrollments--typically employing court-ordered forced busing. This also increases costs to the district--e.g., for more buses.

Two lines of reasoning underlie attempts to achieve demographic equalization of enrollments. First, if children from diverse segments of society are intermixed in a single school, it is assumed that educational resources reaching the school will be spent on all enrollees in a nondiscriminatory manner. Second, physical integration should lead to social interaction between students from different racial-ethnic and socioeconomic backgrounds; in consequence, the alleged lower regard for schooling among minority and lower SES students should be favorably modified. That courts instituting forced busing do not overly rely on the second line of reasoning is illustrated by the Roxbury-South Boston plan in effect during the 1974-75 school year. The notion there seems to have been that children from lower-SES black families could profit from exposure to their similar-SES white counterparts.

While intermixing students from different segments of society in the same school places them under the same general dollar umbrella, this alone cannot defense against any teacher biases--however unconscious or inadvertent--that might operate relative to observable demographic differentials in the enrollment. Flagrant intentional teacher biases might also occasionally surface--the alleged case for South Boston High School. More often, such biases probably are inadvertent, subtle, and almost impossible to detect through occasional observation of an operating classroom. The documentation of subtle teacher biases is illustrated by the investigations of Hanson, Behr, and Bailey (1975) and Fernández, Espinoza, and Dornbusch (1975), later discussed.

Apart from the fact that physical intermixing of students coming from diverse backgrounds seldom is accompanied by appreciable social intermixing, it is not proven that lower achievement on the part of minority and lower SES students results from subcultural or circumstantial tendencies to undervalue the benefits of schooling. Although not unequivocal, recent findings (e.g., Hanson and Schutz, 1975, for instruction at a kindergarten level; Hanson et al., for instruction at a K-3 level) support the view that the interaction of students from different segments of society is not a necessary condition to high achievement on the part of minority and lower SES students. The objectification of initial instructional placement and instructional advance decisions for each student might well prove considerably more effective to achieving equal educational opportunity than a demographic equalization policy--whether forced or voluntary.

Suitably effected, increased social interaction across racial-ethnic and SES categories well might yield badly needed increments to the cohesiveness of the present society. Whether a general objective to integrate the society is worthwhile is not at issue here. Rather, considering that funds available to achieve equal educational opportunity are not unlimited, the issue is whether a demographic equalization policy of any kind merits the costs--in dollars and emotional heat--presently accrued in the pursuit of such a policy. The available evidence suggests that reaching the objective entails spending less rather than more on this particular means.

Equalization of Expense per Unit A.D.A.

Data on teacher qualifications and per capita or unit A.D.A. plant and operating expenditures can be used to determine whether those schools of a district having predominantly minority group or lower SES enrollments operate on slighter or lower-quality resources than other schools of the district. Such input data have been used during the last decade to appreciably reduce resource differentials between schools of a district. Various forms of governmental oversight visited on school finances during the last decade probably have resulted in equitable dollar allocations to the different schools of a district in most instances. While some districts continue to assign a preponderance of recently-credentialled teachers to schools having high minority and lower SES enrollments, it is yet to be proven that this practice has a net discriminatory effect. The inexperience of recently-credentialled teachers might be balanced by less opinionation, greater flexibility, and greater command of the current instructional state-of-the-art.

While interdistrict equalization--e.g., along Serrano-Priest lines--is only beginning to attract attention, the large-city school districts containing concentrations of minority and lower SES students for the most part as yet command adequate per capita resources. Consider, for example, the average expenditures for education per unit A.D.A. for California unified school districts in 1973-74 and for unified districts with A.D.A. in excess of 30K for the same year, provided in Table 1.

It is intuitively appealing that large differentials in school-to-school and district-to-district expenditures per unit A.D.A. should bestow some advantage on enrollments of those schools whose resources permit the largest expenditures per unit A.D.A. While some emotional heat is developing over the proposition that richer school districts should share resources with poorer ones, the costs--in dollars and emotional heat--of achieving resource equalization appear much slighter than the costs of achieving demographic equalization of enrollments. Moreover, one can more nearly envision the realization of resource

equalization than of demographic equalization of enrollments because de facto segregated housing combined with white flight from cities creates unfavorably logistic accompaniments to the emotional heat generated among white neighborhood school advocates. All in all, resource equalization is a means warranting continuing support.

Table 1

Expenditures per Unit A.D.A. during 1973-74 for California Unified School Districts with A.D.A. in Excess of 30K and for the Aggregation of California Unified School Districts

USD	A.D.A.[a]	Expense per[b] Unit A.D.A.	USD	A.D.A.	Expense per Unit A.D.A.
Los Angeles	653K	$1085	Sacramento	52K	$1049
San Diego	128K	1024	Mt. Diablo	47K	1078
San Francisco	69K	1875	Richmond	38K	1288
Long Beach	61K	1174	San Jose	38K	1272
Fresno	58K	994	San Bernardino	34K	1121
Oakland	58K	1403	Torrance	33K	962
Garden Grove	54K	903	Compton	32K	1220
San Juan	54K	965	Average, All USDs in the State	3058K	1094

Note. From California Public Schools Selected Statistics: 1973-74. Sacramento, California: California State Department of Education, 1975.

[a]Total A.D.A. (3058K) is for the school year. All other A.D.A. figures are for the 2nd quarter of the school year.

[b]For reasons too numerous to mention, it costs more to do business in Northern California than in Southern California. As is well-known, San Francisco is the habitat of the $17K streetsweeper.

Equalization of Delivered Instruction

Where educational oversight is not based on explicit proficiency indications keyed to instruction, school personnel have a variety of means for unintentionally discriminating against certain categories of children. A discriminated-against category need not be a conventional demographic category. It might consist of redheaded cut-ups, silent-withdrawn types, or simply children who for one reason or another a principal or teacher dislikes. (Most adults probably can recall such incidents in their own educational histories.) Discrimination against children in nonconventional categories cannot be straightforwardly detected because the categories themselves cannot be anticipated. Yet the means used to detect discrimination against children in certain of the conventional categories should have a salubrious effect on instruction delivered to all children. Some of the means that might be used to discriminate against children of a category in the classroom are:

- Initial underplacement or greater than average underplacement of the child in given instruction (Hanson et al., 1975).
- Flagrant initial overplacement of the child.
- Less personalization of instruction than proficiency indications warrant.
- Postponing advancing a child to next instruction even though available proficiency indications warrant such action.
- Using less challenging proficiency standards than are generally used (Fernández et al., 1975).

When unconscious or inadvertent, such tendencies are characterized as institutionalized racism, classism, sexism, etc. Irrespective of demographic characterization or calling, no individual probably is entirely free of institutionalized bias. Where school personnel deliver instruction with bias, they do not usually do so with conscious intent. Like their counterparts in all other callings, they typically are the victims of inadvertence when bias creeps into their work. The villains of discriminatory delivery are the institutions that, through inaction, allow such biases to go undetected and so to continue.

Student proficiency gains constitute a predominant component of the output schools are funded to effect. Were there no other reason to explicate minimal proficiency objectives and to institute usefully apt and frequent proficiency assessment leading to public disclosure of student proficiency gains, detecting biases in instructional delivery would be a sufficient reason.

The only widely-used achievement testing programs feature standardized, norm-referenced national achievement tests typically administered once annually at certain of the elementary-secondary school grade levels.[2] Test findings often are interpreted--both in the media and by representatives of educational officialdom--as bearing on such questions as educational productivity and distribution of the fruits of education. Yet most such tests in fact assess only general knowledge whose acquisition in part occurs outside the schools and fail to assess much that the schools teach (cf, Follettie, 1976a). While the public and the schools, consonant with national policy, share a commitment to equal educational opportunity, the schools as yet resist installing proficiency assessment programs closely keyed to their instructional offerings. The structure of an illustrative such program--addressing not just bias detection but also instruction-serving and policy-serving objectives--is sketched in Chapter 3.

Because usefully apt and frequent proficiency assessment leading to public disclosure of student proficiency gains does not yet characterize education, it is difficult to document instructional bias. A few recent studies that succeed in documenting bias are discussed in the next section.

DOCUMENTATION OF INSTRUCTIONAL BIAS

Findings for the SWRL/Ginn Kindergarten Program (KP), consisting of Instructional Concepts (ICP) and Beginning Reading (BRP) components, demonstrate that students register high achievement when instruction is well designed to address specified proficiencies and instructional effects are assessed periodically using suitable criterion-referenced exercises (Hanson & Schutz, 1975). As the authors note:

> KP was an outcome of an R&D program commitment pledged by SWRL in 1965 to provide resources to enable schools to reliably teach youngsters to read, beginning in kindergarten, irrespective of the pupil's previous cultural and educational experience and excepting only those individuals with identified physical organic disability. (p. 2)

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[2]Certain of the State Departments of Education are substituting their own programs for the standardized tests. The California statewide testing program (cf, Law, 1975a) is illustrative. The California program is more apt for assessed proficiency domains than are the standardized national tests. However, the program assesses proficiencies only at certain grade levels and these only once annually.

The Kindergarten Program was administered during the 1972-73 school year to over 100K students in some 4K classes of some 2K schools in 18 states. Mean proficiencies were high--80% to 90%--for all categories of such biosocial factors as family income, ethnicity, school locale, Title I eligibility, and reading level as measured by nationally-normed tests. Although mean achievements of minority and lower SES students were slightly below those for majority and higher SES students, the difference in no case exceeded 10 percentage points.

So huge a data base permits one virtually to treat category means and between-categories and within-categories variances as absolute descriptors--but of what? The authors provide the following perspective for Beginning Reading:

> The data on BRP . . . fortuitously provide an opportunity to examine from a fresh perspective the age-old question of individual differences in learning of pupils. All pupils received the "same" instruction--BRP--during the year. At the end of the year, some had learned more than others. Those who learned less tended to be individuals from financially poor, inner-city, ethnic minority families. This aggregate category has become well known to the profession and to the public as the "educationally disadvantaged." The explanation of the variability in academic proficiency that follows from this perspective only strengthens the credibility of the problem without pointing toward any fresh solution. This is where previous inquiries have stopped, counseling general despair or radical revolution in the face of a massive problem which is above and beyond solution by schools.
>
> But the data in the present inquiry permit further examination. The same instructional product, BRP, was used with all pupils. Suppose it were used differentially with pupils. If the instructional product is indeed effective, it would follow that the variability would be created by the instruction [al delivery]. The more effective the instructional product and the greater the differential use with categories of individuals, the greater the ["] individual differences ["] among pupils. (p. 40)

Note the quotation marks inserted around individual differences. The authors overlooked their punch line; the individual differences so obtained would largely be the artifactual product of discriminatory instructional delivery. The argument of course is speculative. Hanson et al. go beyond speculation for one form of discriminatory instructional delivery.

Hanson et al. investigated the effectiveness of three SWRL/Ginn Communication Skills Programs--Reading, Composition, Expressive Skills--in 102 schools differing for certain biosocial characteristics. These programs were administered to over 8K students in the K-3 grades during the 1973-74 school year. Whatever the instructional level of each of these multileveled programs and whatever the category for each of the biosocial factors studied, each program yielded high measured proficiency, excepting only sentence and paragraph comprehension for the earlier--e.g., K-level--blocks of instruction.

Entry placement into the multileveled SWRL/Ginn Reading Program studied by Hanson et al. is facilitated by the use of a Reading Placement Aid--a criterion-referenced achievement exercise whose results suggest an initial placement level for the student based on demonstrated proficiencies. Placement Aid data were available and had been analyzed for 34 participating schools at the time study findings were reported. For these schools, the actual mean entry point into the Reading Program invariably was set lower by the teacher than that suggested by the Placement Aid. Since most students had no difficulty with the portion of the program administered to them, the possibility cannot be dismissed that the underplacement bias of participating schools deprived <u>all</u> students of an opportunity to make greater progress during the school year because they were required to squander initial months of instruction being instructed in proficiencies already acquired. This general bias is consonant with the widely-held view that public-sector organizations of every kind set output objectives lower than could be attained with reasonable effort if they are allowed to do so.

A word of caution on the Placement Aid. The form of the Aid used in the Hanson et al. investigation had not been validated. A form now being developed within a validation framework differs somewhat from the original form. Nevertheless, Hanson et al. believe that suggested placement based on the original form constitutes a ballpark view concerning the point in the program sequence at which instruction should be initiated.

The underplacement bias detected by Hanson et al. was greater for schools containing predominantly minority enrollments than for those containing predominantly majority enrollments, greater for schools whose enrollments reflected lower mean family income than for those whose enrollments reflected higher mean family income, and greater for Title I eligible schools than for ineligible schools. For four schools containing predominantly black or Spanish-surnamed students, the mean entry point suggested by the Placement Aid was approximately 3.6 (Grade 1.8); actual mean entry point was approximately 2.0 (Grade 1.0). For 20 other schools containing predominantly majority students, the mean entry point suggested by the Placement Aid was approximately 4.7 (Grade 2.4); actual mean entry point was approximately 3.8 (Grade 1.9). This might mean that minority students on the average spend the first 8/10 of a school year negotiating

instruction whose proficiency outcomes are previously mastered and only 2/10 of the year negotiating needed instruction. Conversely, it might mean that majority students on the average spend the first 5/10 of a school year negotiating unneeded instruction and the remaining 5/10 of the year negotiating needed instruction. If the Placement Aid warrants such confidence, then all students are discriminated against--no transgression in an era antedating promulgation of an educational Bill of Rights--but minority students are discriminated against to a much greater extent than majority students--which presumably violates intent if not the letter of existing law.

Fernández et al. document the operation of a proficiency standards-setting bias working to the disadvantage of Chicano students during 1974 in San Francisco high schools. Such students were asked to do less than majority students and were led to believe that their achievements were what they should be. Findings reflect a widely-suspected but seldom-documented situation, one wherein, consonant with the tenets of the purest of moralities, well-meaning individuals condescend to "help" those judged unable to make their own way. These findings highlight that, however venal the outcome, conscious venality typically is not the intent of those who discriminate in the delivery of instruction.[3]

The documentation of demographically referenced biases in the schools as yet is sketchy. Such biases are more sensed than documented due to the present paucity of pertinent achievement output data. These data absent, the tendency is to form broad-spectrum social responses such as demographic equalization of enrollments. The possibility that the courts directing most such responses will pick up the subtle unconscious or inadvertent but substantial biases cited or documented above is vanishingly small. The failure of the schools to provide a means for routinely detecting such biases effectively hides them from the public, the courts, and school personnel. The schools then are deprived of the means for self-correction. Sensed bias then might sanction a judicial intervention that itself is incapable of identifying the subtle effects of continuing biases in the integrated classroom.

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[3]Fernández et al. do not state precisely when in 1974--the 1973-74 or the 1974-75 school year--their study was conducted. Issued in July 1975, the report does not mention that San Francisco high schools were integrated by judicial order in September 1974. The report invites entertaining the view that the pattern of omissions stems from a commitment to integrating de facto segregated schools. Although the commitment is commendable, knowing whether the bias documented by the report occurred in schools previously integrated by forced busing is pertinent information.

This cycle of sensed bias and undereffective shotgun response should continue until achievement outputs of the schools are sufficiently-frequently explicated and read into the public domain.[4]

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[4]Instructional bias at the level of the individual has been gaining the attention of school officials in recent years--in the form of the nonlearning lawsuit, e.g., Peter Doe vs. San Francisco Unified School District. When lawyers discover what such suits are all about, soon thereafter a plaintiff will likely win such a suit. Output assessment and instructional responsiveness to it are keys to the future defensing against nonlearning lawsuits.

Chapter 2

SEMIAUTOMATION OF INSTRUCTIONAL STATUS INFORMATION: PRACTICAL SUPPORT FOR INDIVIDUALIZED INSTRUCTION

Widely accepted among educators is the objective to effectively individualize instruction in a classroom having on the order of a 30:1 student-teacher ratio. Individualized instruction is a means to a desired end, rather than the end itself. Instruction is individualized to respond to differential prior pertinent achievements of an enrollment at any point in time and to address differential predispositions of the enrollment regarding effective rates of presentation. Instruction is individualized to increase its effectiveness for all members of the enrollment.

Individualization leading to effective instruction entails frequent determination of a student's instructional status for pertinent proficiencies in currently-instructed segments of each subject-matter area in which the student is concurrently instructed. The evidence--or instructional status information (ISI)--pertinent to each such determination heretofore usually has been informally and intuitively obtained by a classroom teacher. Such evidence often is obtained on the basis of fleeting indications apprehended by the teacher while keeping track of 30 students receiving concurrent instruction in several subject-matter areas. Intuitive evidentiary models tend to break down when extent and frequency of evidence-gathering rises to accommodate the proposition that instruction--however administered--must be effective.

Effective instruction will not be installed if it fails to meet certain practical constraints--e.g., those for cost-attractiveness in light of prevailing budgetary commitments and of cost-effectiveness in human and other terms. The practicality of effectively individualized instruction turns on three issues:

- Frequency of proficiency assessment. How frequently should decisions concerning what next to teach a student stem from instructional status indications keyed to previously administered instruction? The descriptive mean measures used to discuss this issue are the instructional segment and the student-referenced instructional rate.

- Explicitness of proficiency assessment. How explicit should instructional status indications keyed to previously administered instruction be to insure that instruction is effective?

- Teaching-assessment trade-off. Usefully-frequent, usefully-explicit proficiency assessment determined, are practical means available that sufficiently assist proficiency assessment to insure that the teacher's teaching function is not impaired? If so, what are these means?

The state-of-the-art for proficiency assessment using criterion-referenced exercises (CREs) keyed to instructional segments is sufficiently advanced to warrant much greater use of CREs than yet occurs. Conversely, the more compelling portions of the state-of-the-art entail less use or the use of less detailed CREs than perceivers of ultimate nit would like. If segments are sufficiently extensive, it appears warranted to use one CRE to assess the proficiency or proficiencies instructed by each segment of offered instruction and to condition advance to a next segment in the instructional sequence on CRE findings. Entertainably, such exercises sometimes will fail to reveal pertinent information obtained by the teacher using other means. Although present remarks envision proficiency assessment as explicit, this orientation neither implies the assessment of nit nor precludes that teachers occasionally will find cause to override decisions implied by findings for given administrations of given CREs.

Using explicit ISI to condition instructional advance cannot be as efficient as is a teacher operating on an intuitive basis if explicit ISI is generated only infrequently. When an instructional segment for which explicit ISI is generated is quite long--e.g., a year-long sequence in a subject-matter area--findings will tend to implicate long-standing failures of instructional effectiveness that most teachers long ago will have detected and corrected. Annual explicit proficiency-assessment programs--however apt to some purpose--have little contribution to make to individually referenced day-to-day decisions of teachers.[5]

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[5]An illustrative proficiency assessment schedule to be described assumes equipment support of teachers that will not immediately be available in the schools. Where instructional programs and materials are constant over several years and there is little turnover in the instructional workforce, year-to-year changes in proficiency gains for enrollments at the age/grade levels of a school might have straightforward interpretations--e.g., for instructional bias. If a school obtains sound and comprehensive information on pertinent proficiencies of the enrollment at each age/grade level at the beginning and end of a school year, year-to-year variation in proficiency gains might reflect variation in instructional delivery--whether due to bias or to increasing teacher effectiveness. Where year-to-year proficiency gains bounce around, explication of the phenomenon might affect teacher actions in the longer term. To serve a shorter-term teacher interest in gauging instructional effectiveness per student per subject-matter area while dispensing with the somewhat unrealistic constancies assumed for meaningful year-to-year comparisons entails more frequent than year-to-year comprehensive proficiency assessment--semiannual as a minimum.

Cost-return problems plague attempts to use explicit ISI to condition instructional advance when the instructional segment is trivially short. When the segment is quite short--e.g., the instructional frame so widely studied in programmed-book and CAI settings in the past--the aptness of proficiency assessment is degraded by using quite short-term effects to predict longer-term effects, with unfavorable implications for cost-return.

If the instructional segment whose intent is assessed using a CRE is quite short, proficiencies become trivialized, the conditions under which they are assessed typically become inapt, and their assessment becomes a bother in clerical and other senses. Apart from the fact that the information generated is insufficiently apt, its volume tends to be larger than the best of teachers could usefully exploit. Conversely, if the segment is quite long, the teacher using available other means usually will outperform a system supplying explicit apt information because the teacher is not constrained to detect and correct instances of instructional effectiveness only after administration of the segment is completed.

These remarks suggest that usefulness of explicit ISI as a means aiding instructional decisionmaking depends on length of the instructional segment and that optimizing the usefulness of explicit ISI is the classical problem of finding a saddlepoint. This saddlepoint might vary for areas of instruction and characteristics of instructed proficiencies. A characteristic mean saddlepoint is posited below as a ballpark basis for discussing a practical means--in formulation--that sufficiently assists proficiency assessment to insure that the teacher's teaching function is not impaired.

Let the school day consist of six academic periods and the school year of 180 school days. Let an <u>instructional level</u> consist of six period-wide, year-long instructional programs, defined on rate of advance for a hypothetical highest-rate student. Let the offerings of a K-6 elementary school consist of seven instructional levels.

Posited mean length of the instructional segment is nine periods. Thus, each period-wide, year-long instructional sequence consists of 20 segments. Multiplying this value by six (programs) yields 120 segments per instructional level. Multiplying this value by seven (levels) yields 840 segments for the seven-level offerings of the K-6 school. The paradigmatic comprehensive criterion-referenced assessment program (CAP) addressing the 840-segment offerings of the school consists of 840 CREs--each occurring in a number of parallel forms where proficiency-domain extensiveness or nonexhaustibility entails sampling. An actual CAP and associated instruction might reflect variation in segment length around a mean value.

Assume that students successfully negotiate from 60% to 90% of total offerings and that mean successful negotiation is 75%. Using the mean value, a student on the average should successfully negotiate 15 segments per period-wide, year-long sequence during a school year and 90 segments across periods. Given a 30:1 student teacher ratio, a teacher then has cognizance of and/or participates in 15 CRE administrations daily and 2700 CRE administrations annually. That this is not a trivial imposition is illustrated as follows. Assume that a teacher on the average spends six hours daily or 1080 hours annually in the classroom. If each CRE administration costs 10 minutes of the time a teacher spends in the classroom, 2.5 hours daily or over 40% of classroom time is devoted to CRE administrations. Bringing the teacher's investment down to 10% of classroom time while preserving the frequency of assessment posited above entails lowering the cost per CRE administration to no more than two-and-a-half minutes. This can probably only be done while adhering to standards for aptness and reliability of proficiency assessment by semiautomating the administration of CREs and fully automating the preparation of ISI reports referencing student responses to CREs.

An illustrative means for preserving the posited frequency of assessment while placing a 10% upper bound on teacher classroom time given to proficiency assessment is SWRL's school-sited electronic system (SSE). Now in formulation, SSE is described elsewhere (Follettie, 1976b). The system administers CREs keyed to segments of instruction, records student responses, and produces ISI reports and derivative reports with less than one-day turnaround time on a semiautomated basis using means that are both cost-attractive and cost-effective. The system's principal components are:

- A materials library (ML), which houses all system-accommodated exercises (most of which are CREs) on microfiche and audiocassettes.

- A materials index (MI), which provides teachers and students with codes used to retrieve pertinent entries from the materials library and to instruct the system during exercise presentation and report formation.

- A classroom controller (CC) featuring a microcontroller unit (MC) and one or more terminals (CT), which presents material on microfiche and audiotape and records keyed alphanumeric responses to portions of the material for later processing to ISI by the reporting system.

- A school-sited status-progress reporting system (RS) featuring a minicomputer or microcomputer, data interface, and peripherals, which inputs classroom controller records on audiotape and outputs student-group ISI and derivative--e.g., progress--reports in hard-copy form. These reports are available to teachers at the beginning of the next school day following administration of a CRE.

The materials of a CRE are visual-only (80%), aural-only (10%), or visual-aural (10%). Assume that a CRE occurs in five versions. The materials of a visual version use one-fifth of a microfiche; those of an aural version, one-half (one side) of an audiocassette. The five versions of visual materials for a CRE are packaged on five different fiche to permit the simultaneous same-segment proficiency assessment of as many as five students whenever desired. The five versions of aural materials for a CRE are similarly packaged for the same reason.

Teacher-time costs of proficiency assessment using SSE accrue during assignment of students to equipment, retrieval of materials, and other activities culminating in delivery of recorded audiocassettes to the reporting system center for processing. Teacher determinations of instructional responses to ISI and other reports, report filing for future reference, and file review are activities of an instructional, rather than proficiency assessment, nature.

Potential to SSE are functions--e.g., student placement in instruction, the administration of a restricted range of information-demonstration exercises--which are additional to the proficiency-assessment function. If the system's accommodation of proficiency assessment entails administering some 15 CREs per day per 30-student class and administering half as many feedback exercises per class per day, then, on the average, some 180 minutes of terminal time per class per day might suffice. Because demand will vary around average demand and since other functions are potential to the system, it is assumed that each SSE classroom controller services a 90-student superclass instructed by three teachers and that such a controller features five terminals.

Given the following assumptions, it is possible to cost the teacher investment in proficiency assessment that the use of SSE might entail:

- The school is team-teaching organized; three teachers instruct members of a 90-student superclass.
- From 1 to 10 students might be ready to negotiate a specified CRE on any occasion entailing proficiency assessment; typically, five students will negotiate different versions of the same CRE simultaneously.
- The average number of CRE administrations per teacher per day is 15 and per teacher per year is 2700.
- The average number of administrations of feedback exercises, used when a student misses items on a CRE, per teacher per year is 1350.

- Teachers constitute the only classroom personnel.
- A superclass SSE facility consists of a materials library, three materials indexes, five terminals, and one microcontroller unit.
- Certain activities associated with SSE proficiency assessment need be performed on behalf of younger students--e.g., K-2--but older students perform these activities without assistance.
- Teachers on the average need actively participate in the presentation of 10 per cent of all CREs; each such presentation references five students and consumes 15 minutes. This assumption is regarded as somewhat more arbitrary than the others.

The pertinent teacher activities are:

1. CRE materials identification. Administration of a given instructional segment completed, the teacher uses a materials index to determine materials and other pertinent codes preparatory to administering a CRE. Each instance of this activity on the average supports five CRE administrations. Searching the index brings the teacher to a pertinent page showing the codes for the five versions of the CRE. Some 600 such searches will occur annually. Assuming an average search time of 30 seconds, annual teacher-time cost is 300 minutes.

2. Form completion. The teacher completes a form showing one or more material codes used to retrieve appropriate materials from ML, one or more materials subitem codes used to tell the microcontroller unit and RS which portions of materials items are pertinent, a feedback exercise-version code for later use by the student, an administrative code used to instruct RS concerning ISI report characteristics, and a terminal number indicating which terminal the student is to use. One search of the index provides the first three items of information for up to five students. The administrative code will tend to be invariant for CRE administrations. Assuming that forms are completed five at a time, some 600 instances of form completion will occur annually. Assuming average time per instance is 90 seconds, annual cost is 900 minutes.

3. Materials retrieval-loading. For each CRE administration, the pertinent materials are retrieved from ML and loaded into a terminal's reader-player. The teacher does this for K-2 students; older students do it for themselves. Assuming this signifies teacher retrieval-loading in 40% of the instances,

a teacher will perform the activity no more than 1200 times per year. If each instance costs 30 seconds, annual cost is 600 minutes.

4. Teacher participation in presentation. Sixty of the some 600 CRE administrations occurring annually for 5-student groups are assumed to entail teacher participation averaging 15 minutes per presentation. Annual cost is 900 minutes.

5. Materials removal and refiling. Students at all ages should be able to effect materials removal from equipment. Refiling security probably requires that teachers refile all materials. Audiocassette materials require rewinding before refiling. Some 3000 CRE materials items require refiling annually. Assuming a cost of 20 seconds per instance, annual cost is 1000 minutes. (For an entire school, this activity costs no more than nine person-weeks of after-school, part-time effort using minimum-wage personnel. A changed assumption for classroom personnel would transfer this activity from teachers to others.)

6. Gathering tapes. At the end of the school day, a teacher removes recorded audiotape cassettes from the storage unit of each of the superclassroom's five terminals, replaces the recorded cassette with a blank cassette, and handcarries recorded cassettes to the RS center. If the three teachers of a superclass take turns performing the activity, each teacher performs it 60 times per year. Assuming 5 minutes per instance, the teacher-time annual cost is 300 minutes. (For the entire school, this activity costs no more than three person-weeks of after-school, part-time effort using minimum-wage personnel. A changed assumption for classroom personnel would transfer this activity from teachers to others.)

7. Feedback exercises. Feedback exercises are administered only when one or more responses to a CRE are in error. The administration of feedback exercises entails repeating Activities 3 and 5. Assuming feedback exercises are apt on half of all occasions, the annual cost in teacher time is 800 minutes.

The teacher-time cost of the seven activities cited above is 4800 minutes. This represents less than two minutes per CRE administration and is less than 8% of posited teacher time spent in the classroom annually. If Activities 5 and 6 are assigned to nonteaching personnel, the remaining activities use less than 6% of posited teacher time spent in the classroom annually. Fewer CRE administrations than the number cited above or administrative shakedown of the cited activities might further reduce the annual investment to 5% or less.

In those two proficiency domains in which teachers traditionally have fashioned and administered explicit proficiency exercises in abundance--computation and spelling--teachers probably already invest 5% of classroom time--an hour and a half per week--in proficiency assessment activities of an explicit nature. SSE-CAP is formulated to hold down teacher-time costs while meeting a number of other objectives:

- To suitably broaden explicit proficiency assessment in the schools and to accommodate suitably frequent administration of CREs.
- To avoid overkill in the traditional areas of concern.
- To employ neither more nor fewer items than are required to reach the view that a student probably is or is not proficient for knowledge or skill addressed by a given instructional segment.
- To render ISI reports to teachers at the beginning of the next school day following CRE administrations.
- To create an archival data base from which periodic progress reports can be fashioned and special reports can be produced throughout the school year on demand by different teachers teaching the same child.

Some school personnel might oppose explicated proficiency assessment on a variety of grounds. The foregoing projections of teacher-time costs will not still all opposition--nor should they. However, these projections at least should clarify that suitably extensive, explicit proficiency assessment need not transform the teacher into a clerk who no longer has time for teaching. Assuming that information contained in ISI reports appreciably augments the teacher's data base, the teacher's teaching time will not be diminished; rather, the effective use of such time should be increased.

Chapter 3

ACHIEVEMENT INFORMATION MONITORING IN SCHOOLS (AIMS): COST-ATTRACTIVE HARDWARE

Schools universally engage in proficiency assessment but vary widely for form and intent of the assessment program. Programs vary for extent to which keyed to a school's instruction, for frequency of assessment, for explicitness, for extent to which findings assist teacher decisions concerning consequent instructional activities, and for degree to which findings are used for extrainstructional purposes. Deceptive purposes excluded, a program assessing scholastic proficiencies can have one or more of three general objectives:

- To improve effectiveness-efficiency of a classroom teacher's instructional management performance (including the enlistment of parents in consequence of suitably informing them concerning their child's scholastic progress).

- To detect (typically inadvertent or unconscious) demographically-referenced instructional biases occurring in a school or classroom (as a prelude to their correction).

- To describe achievement outputs of the schools consonant with policy requirements at local, state, and national levels.

The first objective addresses a professional need of teachers to individualize instruction to render education effective, where students differ for prior pertinent achievements or preferences regarding rate of instructional presentation. Instruction cannot be effectively individualized unless teachers suitably often receive information concerning achievement effects on students of previously administered instruction. The second objective reflects a civic-moral responsibility--no less of teachers and school officials than of other segments of society--to promptly detect and correct systematic biases of the sort illustrated by findings of Hanson et al. (1975) and Fernández et al. (1975). More often than not, such biases are unconscious or inadvertent. In such cases, school personnel responsible for the bias usually can be expected to self-correct following documentation and reporting of the bias. The third objective addresses a need of education policymakers at all levels to relate outputs to inputs and to spot gaps and imbalances in the production of achievement resources.

Reaching the third objective at state and national levels while serving all objectives at a local level poses a special problem that will not be considered here. The higher-level architecture for achievement information must be sufficiently comprehensive and nonnitty to accommodate the variations in offerings and emphases across school districts. The proficiency assessment program sketched below

accommodates the three objectives at a local level. Although higher-level accommodation of the third objective might modestly influence design of proficiency data bases at school and district levels, the school-sited hardware yielding the lowest-level data base of an all-purpose proficiency assessment program should be indifferent to special higher-level information requirements; the school-sited hardware to be sketched is formulated to provide a lowest-level data base that should prove apt, whatever the higher-level requirements.

DISTRICT-LEVEL PROFICIENCY ASSESSMENT

A district-level proficiency assessment program herein is denoted an AIMS--Achievement Information Monitoring in Schools--program. Installing AIMS in a smaller school district might entail interaction between officials of the interested district and personnel of a designated R&D agency as the basis for producing a district-endorsed application of the generic AIMS reflecting the district's special requirements. Larger districts having their own education R&D capability might adapt a generic AIMS with little or no outside assistance. The components of AIMS are:

- A comprehensive proficiency framework (CPF). CPF specifies areas of instruction for K-12 education, K-entry proficiencies, and those proficiencies considered by the district, operating within a framework of state and local mandates, to underlie effective functioning in the common undertakings of adulthood. Proficiencies underlying effective functioning in the common economic, social, and aesthetic undertakings of adulthood constitute minimal standards for exiting 12th grade. CPF also should specify age/grade-referenced "enroute proficiency minima" that, absent at certain critical points--e.g., the end of grades 2, 4, 6, 8, and 10--seriously jeopardize a student's chances of reaching minimal standards for adult functioning by completion of 12th grade.

- A comprehensive (proficiency) assessment program (CAP). CAP exercises reflect and are keyed to district instruction suitably segmented (see Chapter 2). The CAP structure is a detailed elaboration on CPF. However, CAP and instructional offerings to which CAP exercises are keyed extend beyond the instruction implicated by minimal proficiency standards defined in CPF.

- A student placement program (SPP). SPP batteries are used to place all students in CAP-assessed instruction at the beginning of a school year and to place transfer students in such instruction at any time during the year.

- A school-sited electronic system (SSE). In present formulation, SSE administers CAP exercises, captures responses to these exercises, issues instructional status and progress reports, and

provides the lowest-level data base required for aggregate-analytic studies of educational output for schools and district and for detecting any demographically-referenced biases that might arise in the district. Modestly extended to handle a trivial level of student-system interaction, SSE could also accommodate administration of SPP batteries.

SSE is formulated to be a cost-attractive, cost-effective means for creating and updating a school's proficiency data base and issuing reports to school personnel concerning attained proficiencies for the enrollment. A formulator's view of system design and costs in different configurations is presented elsewhere (Follettie, 1976b). Herein the system is described in terms of materials and student inputs and outputted reports.

FEATURES OF SSE

The school-sited electronic system has four principal components, only two of which feature electronic components. The system's principal components are:

- A materials library (ML), which houses all system-accommodated exercises (most of which are CAP exercises) on microfiche and audiocassettes.
- A materials index (MI), which provides teachers and students with codes used to retrieve pertinent entries from the materials library and to instruct the system during exercise presentation and report formation.
- A classroom controller (CC) featuring a microcontroller unit (MC) and one or more terminals (CT), which presents material on microfiche and audiotape and records keyed alphanumeric responses to portions of the material for later processing to instructional status information (ISI) by the reporting system.
- A school-sited status-progress reporting system (RS) featuring a multi-purpose minicomputer or microcomputer designed specifically to perform RS functions of SSE, a data interface, and peripherals, which inputs classroom controller records on audiotape and outputs student-group ISI and derivative--e.g., periodic progress--reports in hard-copy form.

The system can be configured in various ways, depending on the work it is asked to do. One such configuration references a 90-student superclassroom and employs a partial materials library, three materials indexes, and a classroom controller consisting of a microcontroller unit and five terminals (see Chapter 2). Several alternative configurations are described and preliminarily costed in Follettie (1976b).

However configured, the heart of the system is its classroom controller. The characteristics of a controller terminal suggest the system's usage domain.

A system terminal features a write-calculate entry device (ED) having an 8-character calculator display and a 64-character write-production display, a fiche-cassette reader-player with earphones (RP), and an audiotape storage unit (SU) into which the microcontroller records keystrokes entered through ED. The fiche reader incorporates an inexpensive xy random-access mechanism used to access any frame of a 98-frame (14 columns x 7 rows) microfiche.

The system's visual presentation medium is microfiche--a matrix of microfilm frames. The content of a visual presentation event is bounded by whatever can be placed on a standard page. Content of a microfiche frame can be exclusively alphanumerics or graphics or a mix of the two. Where visual content is graphic, the use of color fiche is an option. The system's aural presentation medium is cassette-packaged audiotape--a linear sequence of discrete segments that the present formulation requires to be serially accessed. Preliminary analysis of aural presentation requirements suggests that random-accessing of aural segments will not be sufficiently often required to compel the outlays that audio random-accessing requires. Content of an audiotape segment can be speech or nonspeech or a mix of the two.

In linear presentation mode, SSE's classroom controller accommodates any exercise whose items or elements occur in fixed sequence and entail visual, aural, or visual-aural display. In random-access presentation mode, the system accommodates any information search-retrieval exercise employing at most 98 page-size information fields as a visual search domain.

Since an SSE terminal incorporates both 64-key alphanumerics and a 4-function calculator, the system accepts a full range of alphanumeric responses in write-entry mode, a reduced range of alphanumeric responses in calculate-entry mode, or a mix of the two. In addition to coded responses to selected-response items, the system accommodates such constructed responses as copying an alphanumeric sequence; spelling a word; indicating whether a two-morpheme structure is two words, a compound word, or a hyphenated word; punctuating a sentence; calculating the solution to a computational problem using pencil-paper; and calculating the solution to a computational problem using the entry-device calculator. The entry device formulation exploits recent advances in the microelectronics industry to yield a product whose features and costs are more nearly akin to those for consumer-market pocket calculators than those for commercial-market TTYs.

FEATURES OF CAP

CAP consists of semiordered sets of criterion-referenced exercises (CREs). Each CRE is SSE-administered and assesses proficiency instructed by one segment of a school's instructional offerings. The number of CREs in CAP depends on the extensiveness of a school's offerings and how finely these offerings are segmented. CAP should be designed to provide proficiency data for a student negotiating given instruction rather frequently but not so frequently that costs in teacher and student time are overbalanced on the side of proficiency assessment. Envisioned frequency of assessment is exemplarized below using a set of paradigmatic assumptions for offerings and segmentation.

- The school offers instruction at K-6 age/grade levels. Its school day consists of six academic periods; its school year, of 180 school days.
- Each of the school's instructional programs is a period-wide sequence that a hypothetical highest-rate student could successfully negotiate in one school year--180 academic periods.
- An instructional level consists of six instructional programs. The school's total offerings encompass seven instructional levels.
- An instructional program on the average is divided into 20 segments. For present purposes, one CRE assesses a student's instructional status following the administration of each segment of instruction. Such a CRE occurs in alternative versions. Each CRE references a well-defined proficiency domain. Its versions are formed by drawing items from the domain according to provisions of sampling theory (with or without replacement).

Consistent with these assumptions, CAP consists of 120 CREs per instructional level or 840 CREs for total offerings of the K-6 school. If, on the average, students successfully negotiate 75% of K-6 offerings during seven school years, a 30:1 student-teacher ratio entails teacher cognizance of and/or participation in 15 CRE administrations daily and 2700 CRE administrations annually. Given this level of proficiency assessment, SSE semiautomates the administration of CREs consonant with holding the teacher's investment to from 5% to 10% of time spent in the classroom (see Chapter 2). In the sense that SSE makes no demands on teacher time during production of ISI and derivative reports, report production is said to be fully automated. The exemplary segmentation of offerings, coupled with the assumption that students on the average successfully negotiate 75% of offerings,

entails obtaining explicit proficiency indications on the average every 12 days per student per instructional program in which enrolled. If each CRE administration costs 15 minutes in student time, the student's investment is less than 5% of time spent in the classroom.

Extensiveness of CAP materials housed in a classroom materials library depends on various administrative considerations. Assume that a classroom controller serves a 90-student superclass instructed by three teachers and that the school wishes to avoid within-year reconstitutions of classroom MLs. A classroom ML on the average then might house complete materials for three instructional levels--those for 360 CREs. Further assume that CREs occur in five alternative (occasionally identical) versions. Apart from sampling implications, the availability of five versions of each CRE in a classroom ML permits a teacher to simultaneously assign a given CRE to as many as five students. The following additional assumptions ground exemplary characterization of materials housed in a classroom ML.

- The five versions of a visual-only CRE each occupy one-fifth of a microfiche. These versions are packaged on five different fiche to permit simultaneous assessment of as many as five students for the same instructional segment. The five versions of an aural-only CRE each occupy one-half (or one side) of an audiocassette, with the same packaging constraints. These conventions extend to visual-aural CREs.

- 80% of CRE materials are visual-only and so use only fiche, 10% are aural-only and so use only audiocassettes, and 10% are visual-aural and so use both. Every 25th CRE fiche is color.

- Associated with each version of CRE is a visual-only feedback exercise. Feedback exercises use 360 black-white fiche.

- Large-lot duplicate costs are 5 cents for black-white fiche, 75 cents for color fiche, and 50 cents for (5-minute) audiocassettes.

Consistent with these assumptions, a classroom ML contains 324 CRE fiche (13 of them color), 360 black-white fiche containing feedback exercises, and 180 audiocassettes. The large-lot duplicate costs of these materials is approximately $135, or $1.50 per student--an expense that probably must be considered annual in light of materials wear with use.

The materials set to a given exercise determined by a teacher using a materials index, the teacher or student obtains these materials from the classroom ML, loads them into a terminal, and initiates presentation of items or elements of the exercise by activating the terminal and entering a student-identifying code and a teacher-supplied

administrative code. Controller output periodically--e.g., daily--is taken from terminal audiotape storage units in the form of recorded cassetted audiotapes and hand-carried to the reporting system center for processing to ISI reports and archival storage. Archival storage is later used to produce derivative--e.g., periodic progress--reports and to serve district objectives referencing the bias-detecting and achievement output-describing objectives cited in the first section.

EXERCISE, RESPONSE, AND DISPLAY OPTIONS

SSE creates a schoolwide proficiency data base that is consistent with the district's comprehensive proficiency framework. From this data base, the system produces certain reports. Not all of the exercises that SSE might be asked to accommodate yield findings pertinent to the data base. Findings that are pertinent to the data base reflect alternative response forms as inputs and alternative informational forms as processed data. Types of exercises and response forms accommodated by the system and options for item-processing outcomes are discussed in this section.

Accommodated Exercises

CAP encompasses CREs yielding findings entering the data base and associated feedback exercises not pertinent to archival storage. SSE also accommodates a restricted range of information-demonstration exercises of an instructional rather than a proficiency assessment nature. If the administrative coding scheme as presently formulated for SSE is slightly modified and appropriate criterion files are entered in the reporting system as needed, the system can also be used to score and report findings relating to ad hoc teacher-formed assessment exercises.

A system asked only to score and report findings relating to ad hoc unrelated exercises need not create and maintain an archival data base. Such a system features slighter on-line and off-line computer storage, a simpler data-processing architecture, and conceptually simpler student-entered instructions to the system than does SSE. Its software slightly modified, SSE can both accommodate its own requirements referencing an AIMS program and teacher-formed exercises that are additional to these requirements.

Imagine that SSE scores and reports findings relating to teacher-formed exercises but does not enter findings in archival storage. Scoring the exercise entails placing a special criterion file in the system's computer storage. Presenting the exercise through the system's reader-player entails producing and coding special materials. More likely, a teacher either would present the items of a special exercise orally or visually on a chalkboard or sheet of paper, thus obviating the need to produce special microfiche and/or audiocassettes. If so,

the system of administrative codes instructing SSE must be slightly modified to enable accommodation of teacher-formed exercises. A dual system of exercises--e.g., CAP exercises referencing a district-wide proficiency framework and special exercises referencing momentary requirements of individual teachers--can be obtained simply by slightly modifying or extending coding conventions and operating options for SSE.

Accommodated Response Forms

A major failing of achievement tests of all kinds--norm-referenced, criterion-referenced, national, state, or local--is a tendency to arbitrarily restrict selected-response item response alternatives to alphanumeric sequences (usually of short length). If cognitive proficiencies loom large in the accomplishments of an intellectually advanced society, then some such proficiencies must be complex and so must reference complex displays. The tendency of test developers has been to trivialize the displays of response alternatives and so to trivialize the cognitive proficiencies at issue. It should be noted that a microfiche frame has no greater capability than a printed page for presenting complex--particularly iconic--displays. Both permit the use of response alternatives that can range up to great complexity. Using response alternatives that are as complex as is warranted has not in recent years been hampered by technological deficiency--or even probably by cost considerations. The stumbling block apparently has been cognitive deficiency on the part of test developers.

SSE accommodates items entailing a wide range of selected responses and a restricted range of constructed responses. While selected-response items might have both visual and aural components, the aural presentation of a series of response alternatives usually will be considered inapt because requiring the storing in short-term memory of earlier-presented alternatives during presentation of alternatives occurring later in the series. Sets of response alternatives usually can and will be presented visually and simultaneously. Visually-presented response alternatives can take alphanumeric, iconic, or mixed form. An alphanumeric response alternative might be a word or numerical value, a phrase or sequence of mathematical symbols, a sentence or paragraph, or a tabular display. An iconic response alternative might be a single illustration--ranging from a simpler display (e.g., a road map symbol) to an extended-complex display (e.g., a portion of a road map)--or might be two or more illustrations in series conveying action or events over time. A mixed response alternative combines alphanumeric and iconic information--as does a daily four-frame comic strip or a figure bearing analog and discrete information.

Each frame of the 98-frame fiche accommodates one item when presentation is visual-only and the response alternatives to one item when the item is selected-response and presentation is visual-aural. Where response alternatives feature extended-complex displays, each frame of a 98-frame fiche in most instances can accommodate an item featuring at

least five response alternatives. Whereas print publishers find it desirable to get as many items as possible onto a page, the publisher of CAP microfiche is constrained to use one frame per item--even if the item uses only a small portion of the frame. Since SSE does not reward those who develop and publish CAP materials for those forms of brevity that candid print publishers would justify on grounds of profitability, the system encourages the development of items whose response alternatives are as extended-complex as is warranted by the cognitive proficiency at issue.

In most instances, the set of response alternatives for an item are adequately represented using black-and-white. This should universally be true for alphanumeric alternatives and often true for iconic alternatives. An item querying spatial location of a point entity within an area or larger structure--e.g., a city within a state or a component in a circuit schematic--or an area within a larger area--e.g., a state within a national map showing state boundaries or a first chassis to be checked out when troubleshooting a multichassis system schematic--typically should not require the use of color. Conversely, an item querying knowledge of one of a set of road map symbols might find the use of color indespensible. The currently-used California statewide achievement testing program makes extensive use of items featuring black-and-white iconic response alternatives (see Law, 1975b). Conceivably, the California program could be rendered more comprehensive and apt through the use of color displays where warranted.

The range of constructed-response items that SSE can accommodate is restricted to those forms that can be computer-processed on a cost-attractive basis. Alphanumeric pattern responses--e.g., spelled words, punctuated sentences--can be accommodated. Such responses typically will be judged correct if entirely conforming to a criterion pattern and judged incorrect if deviating for one or more features of the criterion pattern. For many such responses, the only factor militating against finer description of deviant patterns is cost. Typically, the added cost of finer description will outweigh the benefit to users.

The system's entry device permits constructed responses to computational problems to take any of three forms. First, the student might be asked to calculate a solution using paper-pencil and then to enter the solution. Second, the student might be asked to place the entry device in calculate-entry mode and then to use the calculator to reach the solution. The captured response then is a calculator-referenced sequence of keystrokes underlying production of the offered solution. This information can take alternative legitimate forms. Whatever the form, the system can determine whether the offered solution is correct. Finally, the student might be asked to calculate a solution in calculate-entry mode and then to note and enter the solution in write-entry mode. The system can accommodate each of these computational constructed-response requirements.

The system cannot accommodate extended free linguistic or other alphanumeric responses. Nor can it accommodate iconic pattern responses--both due to the alphanumeric character of the entry device and because processing iconic response patterns against criterion patterns, where possible, is not yet cost-attractive.

With few exceptions--e.g., the California statewide achievement testing program--the tendency of achievement test developers is to use selected-response items whose reponse alternatives are linear alphanumeric displays of the sort one can construct on a conventional typewriter. Overlooked in the debate on macroissues of achievement testing, this constraint alone might account for an appreciable portion of the invalidity or undervalidity of prevailing achievement tests relative to the cognitive proficiencies which are or should be at issue. The reductionism reflected in restrictions placed on extensiveness-complexity of response alternative displays tends to leave unassessed those complex analytic-integrative skills that are the hallmark of cognitive skill in most subject-matter areas--and that many children enrolled in K-6 schools encounter outside the schools in such form as Radio Shack Science Fair kits. Since the items of SSE-administered CAP exercises must use one frame of microfiche whether restricted or extended for content and because such a frame can accommodate as much content as can be placed on a standard page, there seems little incentive to formulate CAP proficiencies to implicate the restricted items that print publishers find profitable. The proficiency hierarchies generated or endorsed by a school district should feature both elemental skills legitimizing items of restricted extent and assembly skills legitimizing extended-complex items.

Item-Processing Outcomes

Cost considerations require the system to report in alphanumerics. Hence, a report cannot reveal the character of a selected or criterion response taking iconic form. The query portion of an item tends always to take alphanumeric form. Requiring a report to recapitulate query information entails expending appreciable space in report printout and in computer storage. Currently favored alternatives are to provide teachers with inexpensive means for quickly determining the content of any item in CAP and to provide students with exercises, each referencing one CRE, showing query portions of the CRE and the correct response to each query.

For exercises entailing constructed responses--all of which must be alphanumeric--the erroneous detail of an incorrect response is lost unless reported. A present assumption is that the content of an incorrect constructed response might interest the teacher but will not interest other users. Hence, the system provides the option of retaining information on the nature of an incorrect constructed response in archival storage for a short time--e.g., from a week to a month or two--after which it is purged to keep extent of the archival data base within reasonable bounds.

An ISI report references the students of an instructional group--e.g., 10 students--and reports results of each student negotiation of a CRE during the reporting period. If the reporting period is one school day--yesterday or the last school day prior to today--a student of an instructional group in most instances will negotiate either zero or one CRE during the period. The findings portion of an ISI report as a minimum probably should show for each student negotiating a CRE a C/N ratio--where C signifies number of items correct and N signifies number of items in the CRE--and, for each failed item, the item code plus the response code for a selected response or the response content for a constructed response.

Teacher and student often will be interested in the nature of the response to a failed item. Imagine that all selected-response items are five-choice and that alternatives are coded A through E. The nature of the offered response to a failed selected-response item is conveyed by appending a response letter code to the item code. To convey the nature of the response to a failed item requiring response construction entails recapitulating the offered response.

Imagine that a given student fails Item 27 of an 18-item CRE whose items are coded from 19 through 36. The C/N ratio then is 17/18 and the failed-item code is 27. One option is to add to this information an indication of the nature of the response to the failed item. A second option is to add both an indication of the response to the failed item and an indication of the correct or criterion response. Report formats for failed item code plus offered response and for failed item code plus offered response plus criterion response are illustrated below for a failed Item 27 occurring in CREs entailing different forms of response.

- Selected response item.
    - 27: C
    - 27: C, A
- Constructed response item: copying an alphanumeric sequence.
    - 27: Plunky popinjoys preem.
    - 27: Plunky popinjoys preem. Plucky popinjays preen.
- Constructed response item: spelling.
    - 27: turtel
    - 27: turtel, turtle

- Constructed response item: compound and hyphenated words.
  - 27: post-nasal
  - 27: post-nasal, postnasal
- Constructed response item: sentence punctuation.
  - 27: "Where she," said Tom, "goes go I."
  - 27: "Where she," said Tom, "goes go I."
    "Where," she said, "Tom goes go I."
- Constructed response item: paper-pencil computation.
  - 27: 12
  - 27: 12, 8
- Constructed response item: calculator computation.
  - 27: 6 x 4 / 2 =
  - 27: 6 x 4 / 2 =, 6 x 4 / 3 =

The choice of options--the first or the second--depends in part on the type of item. For a spelling exercise, using the second option rules out a need for employing feedback exercises. Conversely, for an exercise involving calculator computation, the first option might be preferred because students will need to consult a feedback exercise to determine item content for missed items even if the more extensive second option is selected.

SSE REPORTS

A district-wide comprehensive proficiency framework (CPF) grounds an AIMS program and implicates the instructional programs administered in district schools, the differentiation of programs into progressions of instructional segments, and the specification of one or more proficiencies that each segment is intended to teach. These proficiency implications of instruction are formalized in a comprehensive (proficiency) assessment program (CAP). CAP reflects both those proficiencies addressed by the common instruction of the nation's schools and by less-common instruction of special interest to the district. While a prototypic CAP--that is, a first view of a comprehensive program--probably has not yet been developed, prototypes for certain of the subject-matters of the common instruction or precursors of prototypes already are available. Examples include Law (1975b), which commendably and perhaps fortuitously mirrors Babikian and Pandey (1973) for elementary school mathematics and Legum and

Rosenbaum (1975), which has implications both for a prototypic CAP and a prototypic student placement program (SPP) in reading comprehension (or reading beyond decoding print to speech). Much work in progress at SWRL and like settings either provide additional portions of a prototypic CAP or alternatives to those cited.

ISI Reports

Assuming a 30:1 student-teacher ratio, concurrent administration of six instructional programs per 30-student class, and class division into three 10-student instructional groups per program, a teacher receives ISI reports for 18 different groups. Assuming further that a group on the average negotiates an instructional segment and its associated CRE every 12 school days, 1.5 groups will be assessed daily. On half of all school days on the average, a teacher will recieve one ISI report; on remaining school days, a teacher will receive two ISI reports. The information contained in such a report is illustrated in Table 2.

The illustrative report is concise while reporting full information on missed items. Should a teacher wish to review student progress at this level of detail, full information on missed items is retained for from a week to a month or two in shorter-term archival storage. Longer-term archival storage deletes missed-item data. Thus, if shorter-term archival storage references a two-month period up to the present, the system might purge shorter-term storage of older entries each week, delete missed item data from them, and transfer the reduced entries to longer-term storage.

Useful in their own right as a basis for improving effectiveness-efficiency of classroom instructional management--the first objective of proficiency assessment--ISI reports constitute the performance basis for an archival storage having oversight--second objective--and output descriptive--third objective--implications. The longer-term archival data base derived from information occurring in ISI reports also provides the performance component of periodic progress reports--e.g., report cards--to parents.

The placement of all students at the beginning of a school year and of transfer students throughout the year is rendered efficient by using SPP batteries--specially formed, usually ordered sequences of CREs. When CAP exercises are used in conjunction with SPP batteries, student proficiency gains during the school year can be specified and schools can defend against charges of initial misplacement--whether underplacement or overplacement. Whereas any present tendency to evaluate teachers on effectiveness grounds referencing measured proficiencies at best must be predicated on proficiency profiles for students at the end of a school year, an AIMS program when fully developed would reflect student proficiency gains during the year--

a fairer basis for determining the explicated component of data underlying judgments of teacher effectiveness.

Table 2

Illustrative ISI Report for an Instructional Group Assessed for Proficiency in Spelling

INSTRUCTIONAL STATUS INFORMATION REPORT

EXERCISE NO.: 4309[a] INSTRUCTOR: ANITA COLLINS
DATE: APRIL 5, 1975 INSTRUCTIONAL GROUP: 32[b]

VERSION	STUDENT	C/N	MISSED ITEMS	
2	ANN ACOSTA	18/18		
1	DAN JONES	18/18		
3	TOMMY BROWN	17/18	39: RIFEL, RIFLE	
4	PAM FLETZ	17/18	68: RAVAL, RAVEL	
5	GREG ORIAN	17/18	73: PERPLE, PURPLE	
3	SUE WHITE	16/18	40: NATLE, NATAL	45: LEGULL, LEGAL
2	AL WILLIAMSON	16/18	34: TURTLE, TURTLE	36: GLOBLE, GLOBAL
4	PHIL WILSON	16/18	56: PUPLE, PUPIL	68: RAVIL, RAVEL
5	BETTY GREEN	15/18	77: OREL, ORAL 84: LOYUL, LOYAL	78: RIVLE, RIVAL

DATE: MARCH 30, 1975

1	MARY SMITH	18/18		

[a]This code might signify Instructional Level 4, Program 3 (Spelling), Segment 09.

[b]This code might signify Collins Spelling Group 2.

Periodic Progress Reports

A continuing serious deficiency of the schools is their tendency either to repress or disguise bad news in reports to parents. Parents are not all equally capable of deducing the scholastic proficiencies a child has attained at any point in time or of interpreting such progress against the proficiencies that must eventually be mastered to enable an individual to participate effectively in the common undertakings of adult life. Conversely, most parents are alike in one regard. Aptly counselled in ways they can understand, most parents will prove powerful allies of teachers seeking to instill in their students adulthood-referenced minimal standards for pertinent proficiencies.

The formal means used by the schools to counsel parents are the report card and the parent-teacher conference. The achievement data currently conveyed by report cards and conferences often is vacuous. When, as occasionally happens, such information is extensive, it is not related to a larger proficiency framework which signals unambiguous alarm when the pattern of progress for a student--if maintained--can only mean that the student will complete secondary school education lacking certain proficiencies crucial to effective participation in the common undertakings of adult life.

The archival data base afforded by SSE, if suitably exploited, provides one part of the information parents require as a prelude to effectively assisting teachers to bring all students to minimal proficiency standards. The district's comprehensive proficiency framework provides a basis for detecting progress profiles which are seriously in conflict with the overarching objective that all students should leave secondary school having achieved the minimal proficiency standards.

It is becoming common for school districts to assert that a high school diploma will be withheld if a student completes 12th grade unable to read at an "8th grade level" or unable to read, write, and talk consonant with the requirements of a job interview or other common adult situation. Such a view, of course, maintains the historical fiction that the fault for ineffective instruction rests with the student-consumer of education rather than with those who are paid to provide the service. As fragile and clumsy as it yet is, the notion that receiving a high school diploma should have clear proficiency implications itself is commendable. However, rather than waiting until high school commencement exercises to admit that the schools have failed and to celebrate such failure by rendering a sentence on the student from which there can be no appeal, it would be much

more sensible for the schools to detect and to communicate to parents as early in the student's career as the evidence warrants that progress to date is inconsonant with the mandate placed on K-12 education to prepare the student to deal effectively with the common situations of adult life. The options then are concerted efforts by parents and teachers during the normal school year to bring student proficiencies up to CPF benchmarks and, that failing, additional schooling--e.g., in summer school--for as long as it takes to insure that student proficiencies will conform to CPF minimal standards when K-12 education is completed. International experience suggests that few failures to meet such standards will occur if the schools, acting in concert with suitably informed parents, adamantly refuse to fail. Although the CAP-referenced, SSE-compiled archival data base is insufficient to reaching this objective, it is a necessary component, without which no degree of explication of "adult performance levels or standards" will suffice.

Periodic progress reports to parents should describe level-segment progress of the student for each instructional program in which enrolled, explain in non-technical language the attained proficiencies associated with level-segment progress indications, communicate teacher judgments of effort, and, where progress--if maintained--is inconsonant with the student's completing K-12 education in conformity with minimal proficiency standards, so indicate. Where progress—when judged against CPF benchmarks--is insufficient, a range of options designed to rectify insufficient progress should be communicated to parents. Once developed, all aspects of the progress-reporting architecture save proficiency measures contained in the archival data base and teacher judgments of effort could be placed in SSE's reporting system for use on each occasion a periodic progress report is to be prepared. Teacher judgments of effort would be entered just prior to preparation of such a report. Given these inputs, SSE would prepare the reports.

Special Progress Reports

From time to time, a teacher might want to review recent detailed CRE-based performance of a student or group in a specified instructional program or C/N ratios for the year to date. The system's shorter-term archival data base is queried when a special report of the first kind is required; its longer-term archival data base is queried when a special report of the second kind is required.

DISTRICT OBJECTIVES

District objectives related to proficiency assessment are to detect instructional biases and to describe achievement output for schools of the district. Imagine that a copy of each periodic--e.g., quarterly--increment to a school's longer-term archival data base is transmitted to the district at period's end. Many districts

are required to maintain information on certain demographic characteristics of the district enrollment. Using such information in conjunction with current-year archival data, a district could periodically determine whether demographically referenced biases were creeping into the instructional practices of a school or classroom. It is likely that simply sharing this information within the district would go far to correct any biases that might occasionally surface.

If schools transmitted initial placement data per student per subject-matter area to the district as such data accrued, the district annually or more often could describe achievement output of the schools.

The greatest obstacles to effective and equitable education are the absence of a comprehensive proficiency framework against which instructional status and progress can be assessed and of a system insuring that pertinent data are collected, retained for a sufficient time, and shared by all concerned with achieving equitable education that is as effective as generous support and human ingenuity can make it. The envisioned SSE-administered CAP exercises and resulting automated data base and report production alone do not remove these obstacles. But they are the larger components of an AIMS program conceived as technically sufficient to provide the support required by school personnel dedicated to securing effective and equitable education. AIMS can be had. Present comments assume that the greatest spur to the development and implementation of AIMS would be to render SSE a shelf-item.

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